Life-cycle assessment of local feedstock supply scenarios to compare candidate biomass sources

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Abstract

The use of life cycle assessment (LCA) as a comprehensive tool to assess environmental impacts of bioenergies is recommended. Nevertheless, several methodological points remain under debate, particularly regarding the feedstock production step, which is a key stage of bioenergy chains. The present work focuses on field emissions during feedstock production, improving assessment methods by the use of process-based models. To do so, a real bioenergy chain, the local feedstock supply for a boiler located in northern France, was studied. The LCA compares flax shives, (the reference) with four other biomass sources: Miscanthus, cereal straw, linseed straw, and triticale as a whole plant. Six feedstock supply scenarios were also compared. The study aimed to test a new LCA methodology for agricultural chains by integrating local characteristics (such as climate, soil, and crop management data) and using models to estimate field dynamics of pesticide emissions and soil organic carbon (SOC). Results showed that flax shives and linseed straw had the lowest impacts, except for global warming: as a consequence, supply scenarios with the largest share of flax shives had the lowest impacts. For all selected impact categories, transportation and fertilization were the main contributors. SOC dynamics led to high C sequestration level (e.g. with Miscanthus) or to high CO 2 emissions level (e.g. with flax shives), thus significantly influencing the global warming impact. Sensitivity analysis showed a large influence of allocation method (economic or mass-based). This study demonstrated the relevance of integrating simulation models using local data in agricultural LCAs, especially for dynamics of SOC and pesticide from fields. Moreover, this work brought scientific elements to support the choice of flax shives as the main biomass feedstock, and the ranking of the other sources as alternative biomass supplies for the boiler.

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